

AD 637934

VUF-3021

FINAL REPORT

# VELA UNIFORM PROGRAM

## PROJECT DRIBBLE

# SALMON EVENT

TATUM SALT DOME, MISSISSIPPI

22 OCTOBER 1964

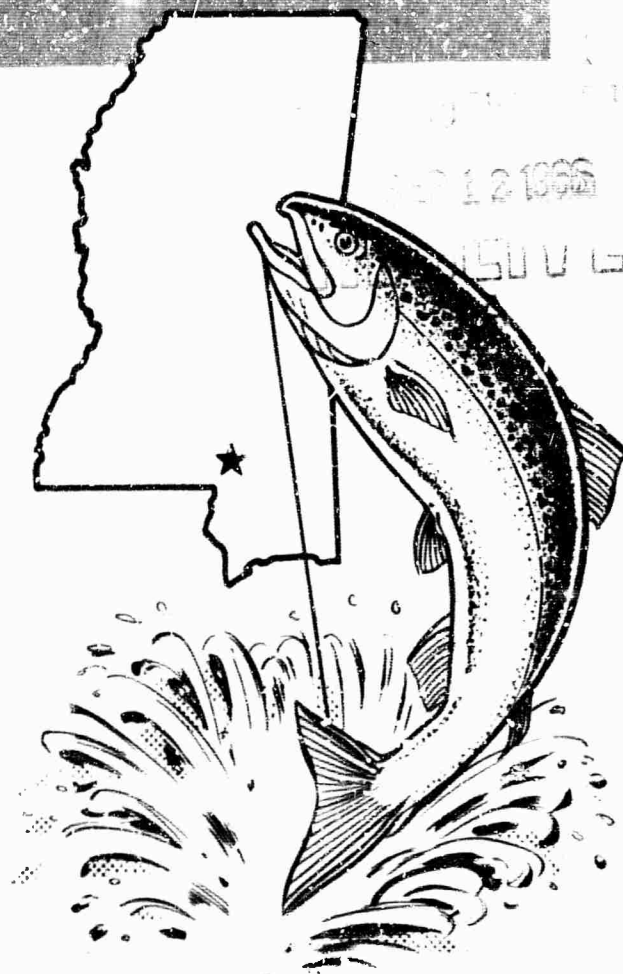
part of an experiment in seismic decoupling at the nuclear level

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## Timing and Firing

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J. M. Colman / R. P. Planchet  
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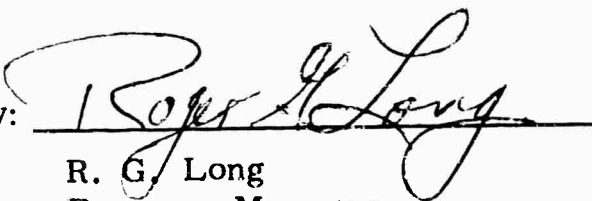
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## TIMING AND FIRING

Project Engineers:

J. M. Colman  
R. P. Planchet

Approved by:

  
R. G. Long  
Program Manager

Edgerton, Germeshausen & Grier, Inc.  
Crosby Drive  
Bedford, Massachusetts

January 1965

## ABSTRACT

On the Salmon event of the Dribble Program, Edgerton, Germeshausen & Grier, Inc. (EG&G) provided timing and firing support as requested by the Atomic Energy Commission. World Time as received from WWV on 22 October 1964 was recorded as 1600:00.0001  $\pm 0.1$  msec, Greenwich Mean Time (GMT).

In addition to the Salmon event, EG&G provided timing and firing support for two high-explosive (H. E.) confirmation experiments conducted under the technical direction of the Lawrence Radiation Laboratory (LRL). The H. E. events were detonated at 1000:00  $\pm 1$  msec and 1100:00  $\pm 1$  msec (GMT), 13 June 1963.

All monitors at the Control Point indicated that the performance of the timing system was completely satisfactory on both the Salmon event and the two confirmation experiments. Both hardwire and radio signals were transmitted to the experimenters as requested.

The EG&G instrumentation for the Salmon event included (1) the special mobile Control Point built for the Dribble Program, (2) a Zero Site station housed in a wooden structure located in the area adjacent to Surface Zero, (3) radio-tone barrels for use of experimenters located at positions remote from the Control Point, and (4) communications nets essential to the transmission of long-range, local, and worldwide countdown.

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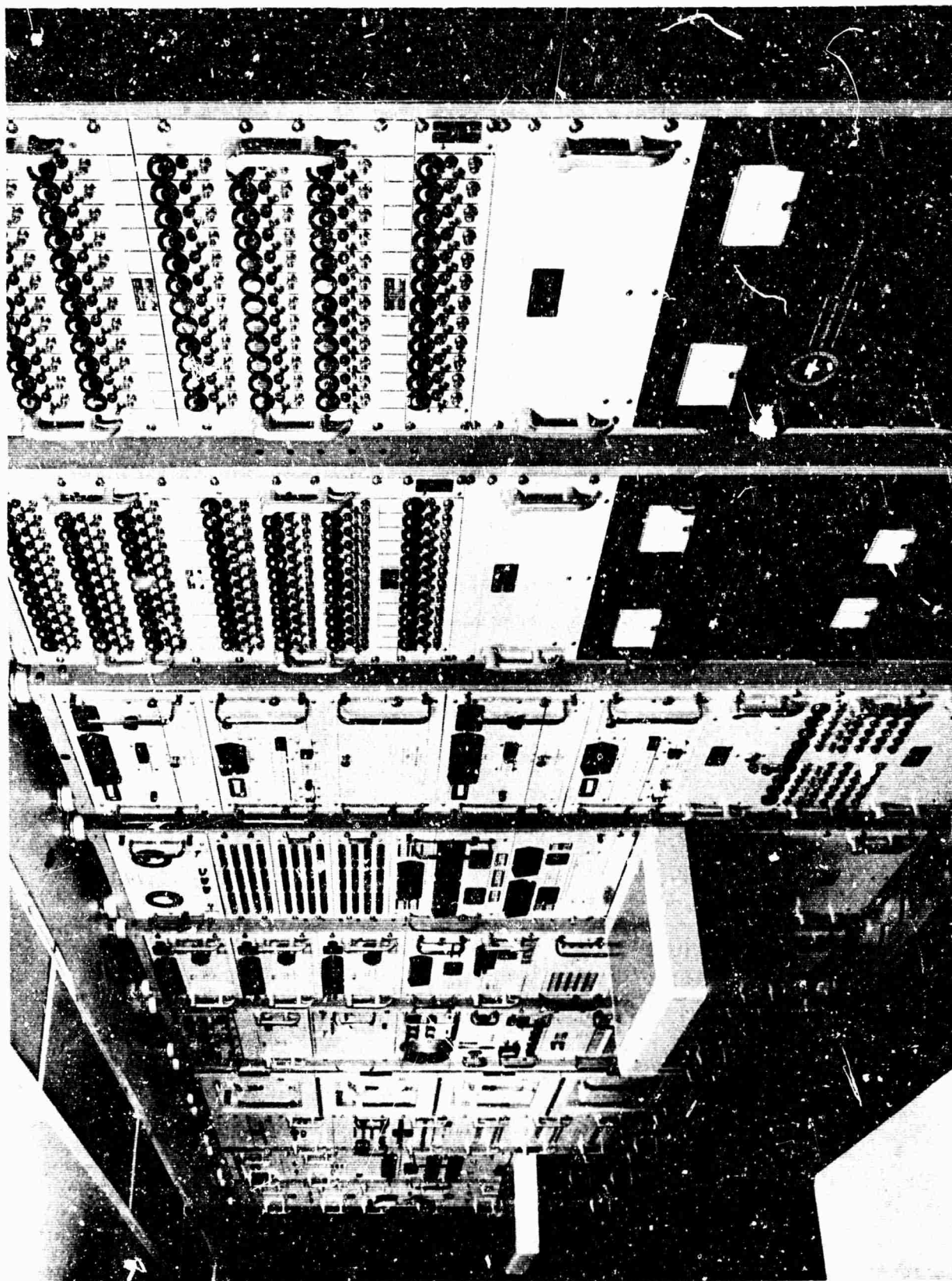
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CONTROL POINT (CP), DRIBBLE PROGRAM



## CHAPTER 1 INTRODUCTION

The principal purpose of the coordinated theoretical and field experimental program (Dribble Program) is to infer the significance of decoupling at the 5-kt level. Three events were originally scheduled:

Salmon for detonation in July 1963, and Tar and Sand to follow about nine months later. Conditions existing at the test site made rescheduling necessary, with Salmon rescheduled for 1964 and Tar and Sand yet to be rescheduled.

Under LRL's responsibility for design and interpretation of the program, two 1000-lb, high-explosive (H.E.) confirmation experiments were conducted in June 1963. These experiments were to aid in determining whether the difference in location of Sand and Tar within the salt dome would significantly affect the seismic signals generated.

The confirmation experiments were detonated 856 m underground in holes E12 and E13 on 13 June 1963. The first shot was fired at 1000:00 (GMT) and the second at 1100:00 (GMT). Immediately following each shot, EG&G supplied LRL with the detonation time accurate to 1 msec. This detonation time was controlled to within  $\pm 1.0$  msec of the predicted zero time.

The Salmon event was detonated 828 m underground on 22 October 1964 at 1600:00.0001  $\pm 0.1$  msec (GMT), corrected 0.004 sec for WWV propagation delay. Time of detonation was officially recorded and reported to LRL immediately following detonation. This detonation time was also controlled to within  $\pm 1.0$  msec of the predicted zero time.

EG&G performed the timing and firing services for all detonations, utilizing a mobile Control Point trailer instrumented by EG&G especially

for the Dribble Program. The site for the three events was within the Tatum Salt Dome in Lamar County, Mississippi, approximately twenty miles southwest of Hattiesburg, Mississippi.

## CHAPTER 2

### PROGRAM SUPPORT

#### 2.1 CONFIRMATION EXPERIMENTS

The confirmation experiments were conducted under the technical direction of the Lawrence Radiation Laboratory (LRL), with the responsibility for timing and firing delegated to EG&G and the responsibility for arming the H. E. charges delegated jointly to EG&G and the Sandia Corporation. The two high-explosive detonations occurred on 13 June 1963 in instrument holes E12 and E13. To accomplish its assigned tasks, EG&G furnished a Control Point trailer, two Zero Site packages, twenty-two radio-tone receivers, signal relays, and fiducial equipment. A packaged timing station was also shipped to the test site for use if a large number of timing signals were required at any one location. It was determined, however, that all timing signals could be efficiently supplied directly from the Control Point.

EG&G personnel arrived at the Dribble site on 20 May 1963, and equipment readiness was established, as required, for system dry runs beginning on 10 June 1963. EG&G coordinated the signal requirements and conducted full-power, full-frequency runs simultaneously for each emplacement twice daily beginning on 10 June. The H. E. charges were armed at approximately 0830 (GMT) 13 June and detonated on that day, the first at 1000:00 (GMT) and the second at 1100:00 (GMT). All signals were sent as programmed; however, one tone barrel at a USC&GS station failed to operate because of a malfunction of the SHOT RUNS ONLY switch. Shortly after the H. E. events, the Salmon shot was postponed. At this point the EG&G equipment was secured and EG&G personnel returned to the Boston laboratory.

Tabulated on the following pages are the final signal requirements for the H.E. experiments (Table 2.1) and the run schedule (Table 2.2).

## 2.2 SALMON EVENT

Salmon was a 5-kt nuclear device detonated underground at Station 1A on 22 October 1963 to provide experimental data for the study of seismic-wave propagation and decoupling.

The event was conducted under the technical direction of LRL. EG&G responsibilities included (1) timing and firing, with signals transmitted via both hardwire and radio tone, (2) device arming (conducted jointly with Sandia), and (3) broadcasting of the countdown over local, long-range, and worldwide nets. As on the confirmation experiments, EG&G provided radio-tone barrels for experimenters remote from the Control Point. The following additional equipment and services were provided at the request of LRL and the other participating agencies.

- (1) The output of the geophones, operated by LRL post-shot listening group, were connected to the PA system.
- (2) A microphone was installed in Trailer 34 and wired to provide LRL with an override capability in the use of the EG&G PA system. The microphone was utilized frequently by LRL to make local announcements.
- (3) EG&G personnel designed in the field a 200-cps tone generator to supply audio to high-power, long-range transmitters. The tone sequence consisted of the following tones and frequencies:
  - (a) 200-cps, 100-msec tone every 1 sec
  - (b) 200-cps, 200-msec tone every 5 sec
  - (c) 200-cps, 400-msec tone every 30 sec
  - (d) 200-cps, 500-msec tone at shot instant

Table 2.1 Signal Requirements for Confirmation Experiments.

| Agency                                   | Signals Received<br>(w - hardwire,<br>r - radio)                              | Monitor  |
|--|---|--|
| <u>Lawrence Radiation Laboratory</u>     |   |  |
| Station E12 (H.E. charge)                | -3.5 min (w), 0 (w),<br>Redbox power relay (w)                                | a-c line, a-c load,<br>a-c stability, dc,<br>arm, X-unit, fire |
| Station E13 (H.E. charge)                | -3.5 min (w), 0 (w),<br>Redbox power relay (w)                                | a-c line, a-c load,<br>a-c stability, dc,<br>arm, X-unit, fire |
| <u>U. S. Coast &amp; Geodetic Survey</u> |   |  |
| Seismic Station                          | -4 sec (r), 0 (r), 14<br>tone barrels, 1 pps on<br>Channel 1                  |  |
| <u>Sandia Corporation</u>                |   |  |
| Trailer MM, Recording<br>Park            | -30 min (w), -15 min<br>(w), -1 min (w), -30<br>sec (w), -5 sec (w),<br>0 (w) | power  |
| <u>Stanford Research Institute</u>       |   |  |
| SRI Trailer, Recording<br>Park           | -30 sec (w), -15 sec<br>(w), -5 sec (w)                                       | power  |

Table 2.2 Schedule of Runs for Confirmation Experiments.

| Date    | Type   | Start<br>(GMT) | Zero Time<br>(GMT) | Instrument Hole |
|---------|--------|----------------|--------------------|-----------------|
| 6-10-63 | FPFF   | 1700           | 1730               | E12             |
| 6-10-63 | FPFF   | 1800           | 1830               | E13             |
| 6-10-63 | Signal | 1930           | 1000               | E12             |
| 6-10-63 | Signal | 2030           | 2100               | E13             |
| 6-11-63 | Signal | 1530           | 1600               | E12             |
| 6-11-63 | Signal | 1630           | 1700               | E13             |
| 6-11-63 | Signal | 1830           | 1900               | E12             |
| 6-11-63 | Signal | 1930           | 2000               | E13             |
| 6-12-63 | Signal | 1530           | 1600               | E12             |
| 6-12-63 | Signal | 1630           | 1700               | E13             |
| 6-12-63 | FDR    | 1830           | 1900               | E12             |
| 6-12-63 | FDR    | 1930           | 2000               | E13             |
| 6-13-63 | Live   | 0930           | 1000               | E12             |
| 6-13-63 | Live   | 1030           | 1100               | E13             |

FPFF - full power, full frequency  
FDR - final dry run

This tone sequence (pulse) train was provided for the entire 2-hr, 35-min countdown. Simultaneously with the Hattiesburg effort, these same tones were generated by EG&G Las Vegas personnel and supplied to long-range transmitters at the Nevada Test Site.

- (4) Technical assistance was given to the Bureau of Mines in making a wiring connection for an electrically latched relay.

EG&G personnel arrived at the Hattiesburg site on 4 August 1964 and remained there until shortly after the 22 October shot date. Signal dry runs were begun on 1 September and continued thereafter according to the schedule requested by the experimenting laboratories. The event was originally planned for detonation on 22 September; however, because of adverse weather conditions, a series of postponements was necessary and the device was not fired until 22 October 1964. EG&G recorded detonation time as 1600:00.0001  $\pm$  0.1 msec (corrected for a 0.004 sec propagation delay between WWV (Beltsville, Maryland) and the Tatum Salt Dome). All EG&G systems operated properly, and monitors indicated that all signals were sent and received as programmed.

A double 500-msec pulse was transmitted at zero time; however, this signal did not affect the accuracy of the event timing or of the event records. A record of the long-range audio was made for the 2 hr and 35 min duration of the countdown. Paper records were also made of the information transmitted before and after zero time. With the aid of these paper records, and the paper records used to monitor relay closures, EG&G determined that a momentary power dropout occurred at the zero site at +0.5 sec. This dropout injected a noise pulse into the fiducial box at the zero site, causing a false fiducial signal to be transmitted to the Control Point trailer. Upon receipt of the false fiducial signal,

equipment in the trailer transmitted a second 500-msec, 200-cps burst. The first 500-msec, 200-cps burst was true zero (shot instant); the second burst should be disregarded. The +1 sec, 100-msec, 200-cps burst was not transmitted because it was blocked out by the second 500-msec, 200-cps burst transmitted at +0.5 sec.

Presented on the following pages are:

Table 2.3 Salmon Signal Print-out Sheet.

Table 2.4 Salmon Signal Requirements.

Table 2.5 Schedule of Runs for Salmon Event.

Figure 2.1 Chart Transcript of Monitor Signals During Live Run.



Table 2.3 Salmon Signal Print-out Sheet.

| Actual Time (GMT)* | Programmed Time (GMT) |
|--------------------|-----------------------|
| 1602:59.9957       | +3 min                |
| 1600:00.9147       | +1 sec                |
| 1600:00.4922       | +0.5 sec              |
| 1600:00.0001       | Zero Fidu Pulse       |
| 1559:59.4939       | -0.5 sec              |
| 1559:58.9960       | -1 sec                |
| 1559:57.9918       | -2 sec                |
| 1559:57.4939       | -2.5 sec              |
| 1559:56.9966       | -3 sec                |
| 1559:54.9924       | -5 sec                |
| 1559:49.9907       | -10 sec               |
| 1559:44.9931       | -15 sec               |
| 1559:29.9926       | -30 sec               |
| 1558:59.9953       | -1 min                |
| 1557:59.9922       | -2.5 min              |
| 1556:59.9960       | -3 min                |
| 1556:29.9902       | -3.5 min              |
| 1554:59.9947       | -5 min                |
| 1544:59.9940       | -15 min               |

\* Recorders were set up on a local time (CST) schedule; however, this print-out sheet has been revised to indicate actual times in GMT.

Table 2.4 Salmon Signal Requirements.

| Agency                               | Signal Received<br>(w - hardwire,<br>r - radio)  | Monitor   |
|--------------------------------------|--|---|
| <u>Lawrence Radiation Laboratory</u> |  |   |
| Red Shack, TDMS                      | -15 min (w), -3 min<br>(w), -1 min (w), 0 (w)  |   |
| Trailer No. 34, TDMS                 | 0 (w)  |   |
| Trailer No. 40,<br>Recording Park    | -15 min (w), -30 sec<br>(w), -1 sec (w)  | Temperature<br>and power  |
| Photo Station No. 1                  | -3 sec (w)   |   |
| Photo Station No. 2                  | -3 sec (w)   |   |
| Photo Station No. 3                  | -3 sec (w)   |   |
| Photo Station No. 4                  | -3 sec (w)   |   |
| Flasher (GZ)                         | 0  |   |
| Device, Station No. 1,<br>A&F        | -15 min (w), -3.5 min<br>(w), -2 min (w), -2<br>sec (w), 0 (w), +0.5<br>sec (w), power relay | a-c line, a-c load,<br>a-c stability, d-c<br>stability, arm, X-<br>unit, zipper, fire |
| <u>U. S. Geological Survey</u>       |  |   |
| USGS 6.1                             | -1 min (w), +5 sec<br>turnoff  |   |
| H. T. 37 Complex                     | -1 min (w), 0 (w),<br>1 pps (r), +3 min (w),<br>+5 min turnoff                               |   |

Table 2.4 Salmon Signal Requirements (continued).

| Agency                                   | Signal Received<br>(w - hardwire,<br>r - radio)                                    | Monitor         |
|--|--|-----------------|
| <u>U. S. Coast &amp; Geodetic Survey</u> |  |                 |
| Seismic Stations                         | -2 sec (r), 0 (r),<br>1 pps (r), (20 tone<br>barrels*)                             |                 |
| Station 4E                               | -5 min (r), -2 sec<br>(r), 0 (r)   |                 |
| <u>Sandia Corporation</u>                |  |                 |
| Trailer MM, Recording Park               | -15 min (w), -3.5<br>min (w), -1 min (w),<br>-5 sec (w), -1 sec (w)                | Tape            |
| <u>Stanford Research Institute</u>       |  |                 |
| Trailer SRI, Recording Park              | -15 min (w), -5 min<br>(w), -1 min (w), -30<br>sec (w), -15 sec (w),<br>-5 sec (w) | Tape, a-c power |
| <u>U. S. Bureau of Mines</u>             |  |                 |
| Station 3E                               | -5 min (r), -10 sec (r)  |                 |

\* Two each at 1E and 1S and one each at 2E through 6E, 2S through 6S, Baxterville Oil Fields, Purvis, Lumberton, Columbia, Hattiesburg, and Gulf Refinery. The 250-msec duration, 1-pps pulses start at -2 sec, and end at +3 min.

Table 2.5 Schedule of Runs for Salmon Event.

| Date    | Type          | Start<br>(GMT) | Zero Time<br>(GMT) | Remarks        |
|---------|---------------|----------------|--------------------|----------------|
| 9-1-64  | Signal & L.R. | 1355           | 1600               |                |
| 9-2-64  | Signal        | 1530           | 1600               |                |
| 9-3-64  | Signal        | 1530           | 1600               |                |
| 9-4-64  | Signal        | 1530           | 1600               |                |
| 9-8-64  | Signal        | 1530           | 1600               |                |
| 9-8-64  | Signal        | 1930           | 2000               |                |
| 9-9-64  | Signal        | 1530           | 1600               |                |
| 9-9-64  | Signal        | 1930           | 2000               |                |
| 9-10-64 | FPFF & L.R.   | 1355           | 1600               |                |
| 9-10-64 | Signal        | 1830           | 1900               |                |
| 9-10-64 | Signal        | 2100           | 2130               |                |
| 9-11-64 | Signal        | 1530           | 1630               | Delayed 30 min |
| 9-11-64 | HDR           | 1830           | 1900               |                |
| 9-14-64 | FPFF & L.R.   | 1355           | 1630               | Delayed 30 min |
| 9-14-64 | Signal        | 1830           | 1900               |                |
| 9-14-64 | FPFF          | 1930           | 2000               |                |
| 9-15-64 | Signal        | 1530           | 1600               |                |
| 9-15-64 | Signal        | 1930           | 2000               |                |
| 9-16-64 | Signal        | 1530           | 1600               |                |

Table 2.5 Schedule of Runs for Salmon Event (continued).

| Date    | Type           | Start<br>(GMT) | Zero Time<br>(GMT) | Remarks |
|---------|----------------|----------------|--------------------|---------|
| 9-17-64 | Signal         | 2000           | 2030               |         |
| 9-18-64 | Signal         | 1630           | 1700               |         |
| 9-18-64 | Signal         | 2030           | 2100               |         |
| 9-20-64 | Signal & L. R. | 1755           | 2000               |         |
| 9-20-64 | Signal         | 2445           | 2515               |         |
| 9-20-64 | Signal         | 2700           | 2730               |         |
| 9-21-64 | Signal         | 0600           | 0630               |         |
| 9-21-64 | Signal & L. R. | 1355           | 1600               |         |
| 9-21-64 | Signal         | 2115           | 2145               |         |
| 9-21-64 | Signal         | 2445           | 2515               |         |
| 9-22-64 | Signal         | 1530           | 1600               |         |
| 9-22-64 | Signal         | 1930           | 2000               |         |
| 9-23-64 | Signal         | 1530           | 1600               |         |
| 9-24-64 | Signal         | 1530           | 1600               |         |
| 9-24-64 | Signal         | 1930           | 2000               |         |
| 9-25-64 | Signal & L. R. | 1355           | 1600               |         |
| 9-25-64 | Signal         | 1930           | 2000               |         |
| 9-26-64 | Signal         | 1530           | 1600               |         |
| 9-26-64 | Signal         | 1930           | 2000               |         |

Table 2.5 Schedule of Runs for Salmon Event (continued).

| Date    | Type          | Start<br>(GMT) | Zero Time<br>(GMT) | Remarks  |
|---------|---------------|----------------|--------------------|--|
| 9-27-64 | FDR & L.R.    | 1355           | 1815               | Two delays occurred, one of 15 min and one of 2 hr. During second delay, local run discontinued. Run continued with L.R. only. |
| 9-27-64 | Signal        | 2000           | 2030               |  |
| 9-28-64 | L.R.          | 1355           | 1600               |  |
| 9-28-64 | Signal        | 2130           | 2200               |  |
| 9-29-64 | Signal & L.R. | 1355           | 1600               |  |
| 9-30-64 | Signal & L.R. | 1355           | 1600               |  |
| 10-1-64 | Signal & L.R. | 1355           | 1600               |  |
| 10-1-64 | L.R. V.A.     | 2200           | 2300               |  |
| 10-2-64 | L.R.          | 1355           | 1600               |  |
| 10-2-64 | L.R. V.A.     | 2200           | 2300               |  |
| 10-4-64 | L.R.          | 1355           | 1600               |  |
| 10-4-64 | L.R. V.A.     | 2200           | 2300               |  |
| 10-5-64 | Signal & L.R. | 1355           | 1600               |  |
| 10-5-64 | Signal        | 1930           | 2000               |  |
| 10-5-64 | L.R. V.A.     | 2200           | 2300               |  |
| 10-6-64 | Signal & L.R. | 1355           | 1600               |  |
| 10-6-64 | L.R. V.A.     | 2200           | 2300               |  |

Table 2.5 Schedule of Runs for Salmon Event (continued).

| Date     | Type          | Start<br>(GMT) | Zero Time<br>(GMT) | Remarks                              |
|----------|---------------|----------------|--------------------|--------------------------------------|
| 10-7-64  | Signal & L.R. | 1355           | 1600               |                                      |
| 10-7-64  | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-7-64  | FDR           | 2230           | 2300               |                                      |
| 10-8-64  | Live & L.R.   | 1355           | none               | Four 1-hr delays;<br>shot cancelled. |
| 10-8-64  | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-9-64  | Signal & L.R. | 1355           | 1600               |                                      |
| 10-9-64  | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-11-64 | Signal & L.R. | 1355           | 1600               |                                      |
| 10-11-64 | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-11-64 | FDR           | 2230           | 2300               |                                      |
| 10-12-64 | Live & L.R.   | 1355           | none               | Five 1-hr delays;<br>shot cancelled. |
| 10-12-64 | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-13-64 | Signal & L.R. | 1355           | 1600               |                                      |
| 10-13-64 | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-14-64 | Signal & L.R. | 1355           | 1600               |                                      |
| 10-14-64 | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-15-64 | Signal & L.R. | 1355           | 1600               |                                      |
| 10-15-64 | L.R. V.A.     | 2200           | 2300               |                                      |
| 10-16-64 | L.R.          | 1355           | 1600               |                                      |

Table 2.5 Schedule of Runs for Salmon Event (continued).

| Date     | Type            | Start<br>(GMT) | Zero Time<br>(GMT) | Remarks       |
|----------|-----------------|----------------|--------------------|---------------|
| 10-16-64 | Signal          | 1745           | 1800               |               |
| 10-16-64 | L.R. V.A. & FDR | 2200           | 2300               |               |
| 10-17-64 | Signal & L.R.   | 1355           | 1600               |               |
| 10-17-64 | L.R. V.A.       | 2200           | 2300               |               |
| 10-18-64 | Signal & L.R.   | 1355           | 1600               |               |
| 10-18-64 | L.R. V.A.       | 2200           | 2300               |               |
| 10-19-64 | Signal & L.R.   | 1355           | 1600               |               |
| 10-19-64 | L.R. V.A.       | 2200           | 2300               |               |
| 10-20-64 | Signal & L.R.   | 1355           | 1600               |               |
| 10-20-64 | L.R. V.A.       | 2200           | 2300               |               |
| 10-21-64 | L.R.            | 1355           | 1600               |               |
| 10-21-64 | L.R. V.A. & FDR | 2200           | 2300               |               |
| 10-22-64 | Live            | 1355           | 1600               | Device fired. |

Legend: FFFF - full power, full frequency  
 L.R. - long range  
 L.R.V.A. - long range voice announcement  
 FDR - final dry run  
 HDR - hot dry run



10/22/64  
LIVE RUN

1000 HRS

RECORDER #1  
DECODER #1

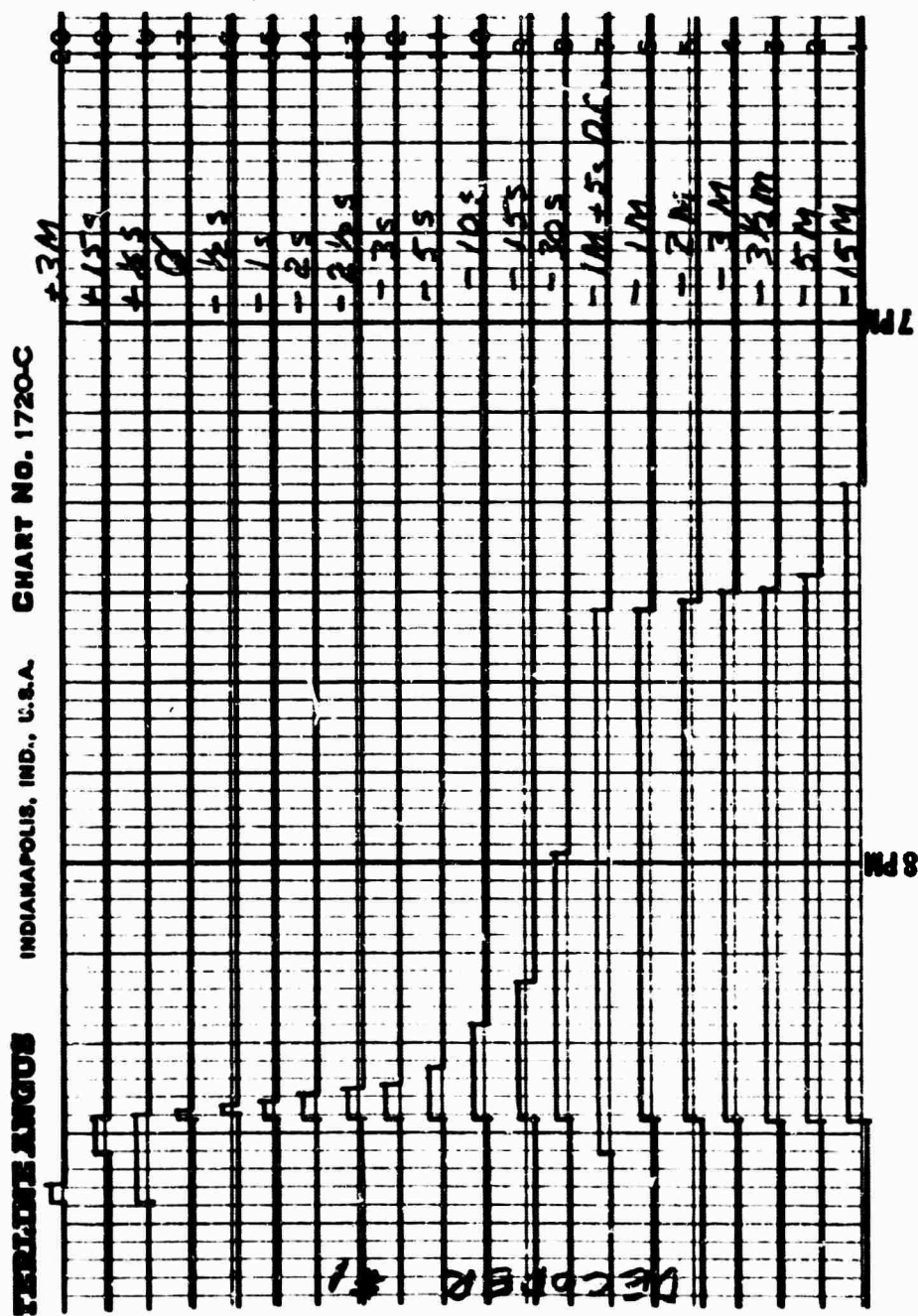


Fig. 2.1. Chart Transcript of Monitor Signals During Live Run.

## CHAPTER 3

### INSTRUMENTATION

#### 3.1 CONTROL POINT INSTRUMENTATION

The EG&G timing and firing system provided an accurately timed sequence of signals used to (1) fire the nuclear and non-nuclear devices employed in the Dribble Program and (2) control experimental equipment, at various locations, from times prior to zero to times after zero. The signals, which were distributed by hardwire and radio to experimenters and to the Zero Site, were generated, transmitted, and monitored from a mobile Control Point trailer which served as the main element of the timing and firing system.

The T&F system is subdivided into eight subsystems whose inter-related functions combine to accomplish the design capability of the overall system. The sections which follow contain (1) brief functional descriptions of each subsystem, (2) block diagrams of each subsystem, and (3) a listing of equipment comprising each subsystem.

##### 3.1.1 World Time System (Fig. 3.1)

The nucleus of the timing and firing system is the World Time system, whose primary function is to furnish ultra-precise timing pulses (synchronized with the standard time transmission from Station WWV) to the timing system. In addition, World Time system voice-count and command-control consoles exercise control over various operational functions throughout the system and display programmed and countdown times on their front panels. Equipment units comprising the World Time system include:

- (1) two Manson Frequency Standards, Model RD-180,
- (2) one Oscillator Divider, Type OR-8A,

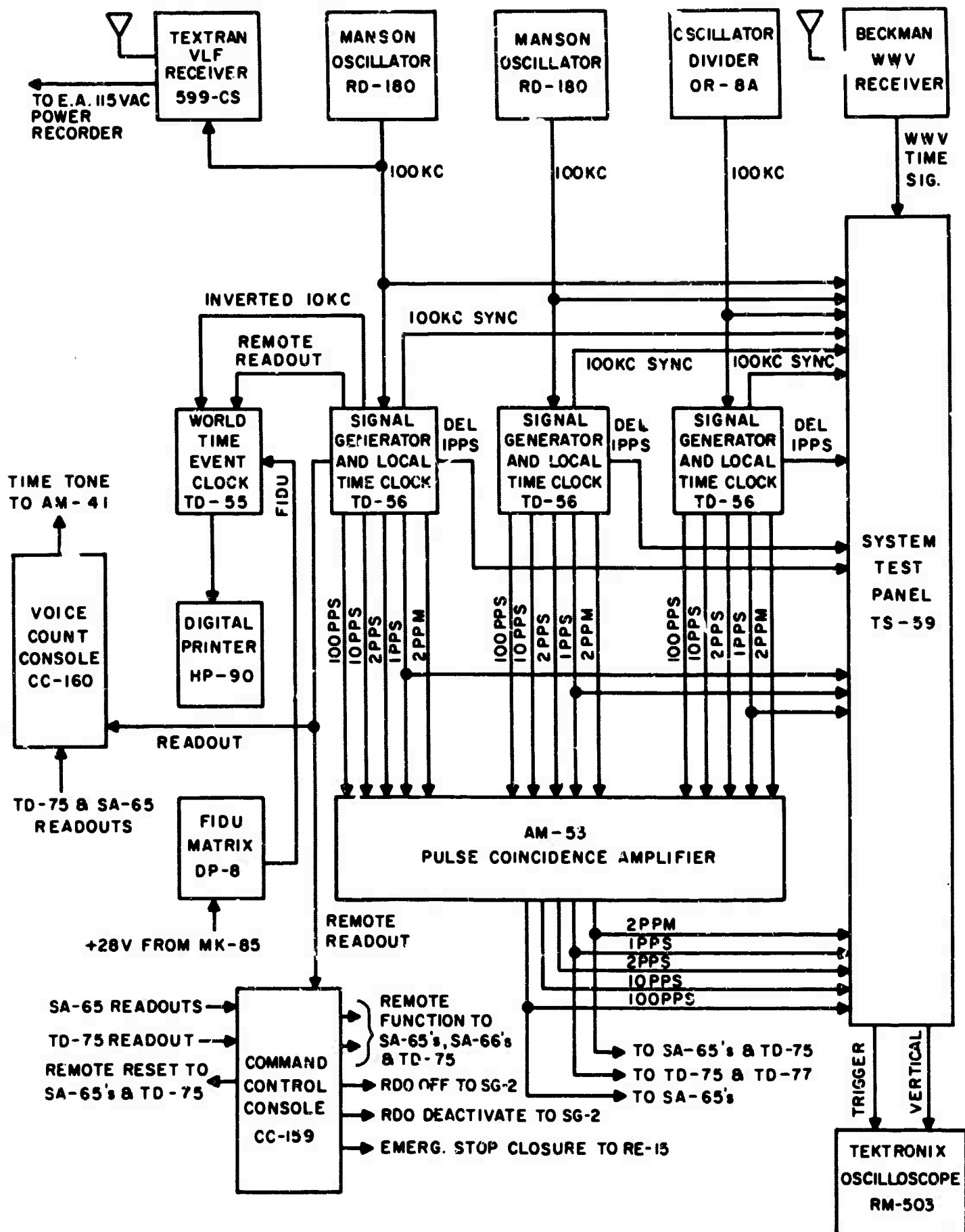


Fig. 3. 1. World Time System.

- (3) three Signal Generator and Local Time Clocks, Type TD-56,
- (4) one Pulse Coincidence Amplifier, Type AM-53,
- (5) one Voice Count Console, Type CC-160,
- (6) one Command Control Console, Type CC-159,
- (7) one System Test Panel, Type TS-59,
- (8) one Oscilloscope, Dumont 401B,
- (9) one WWV VHF Receiver, Beckman 905,
- (10) one VLF Tracking Receiver, Textran 599 CS,
- (11) one World Time Event Clock, Type TD-55,
- (12) one Digital Recorder, Hewlett-Packard HP-90-561B, and
- (13) one Fidu Matrix, Type DP-8.

During the Salmon event, a tone-generator network (Fig. 3.2) was utilized to furnish various tones and the fiducial signal from the Zero Site to remote locations via long-range and local transmitters. The network consisted of Marker, Type TD-77, a 200-cps tone generator (constructed in the field by EG&G engineering personnel), and Dual Six Channel Amplifier, Type AM-44A.

### 3.1.2 Timing System (Fig. 3.3)

Upon receipt of the ultra-precise timing pulses from the World Time system, the timing system, which is the main signal-producing subsystem of the T&F system, converts these timing pulses into controlled sequences of relay closures. These sequences are supplied to the signal distribution system for processing and distribution. The timing system also provides a visual indication of (1) the instantaneous clock count in seconds and tenths of seconds and indicates direction of count (+ or -); the countdown time in hours, minutes, and seconds; and (3) the occurrence of the relay closures. Equipment units comprising the timing system include:

- (1) two Signal Sequencers, Type SA-65,
- (2) two Decoders, Type SA-66, and
- (3) one Countdown Clock, Type TD-75.

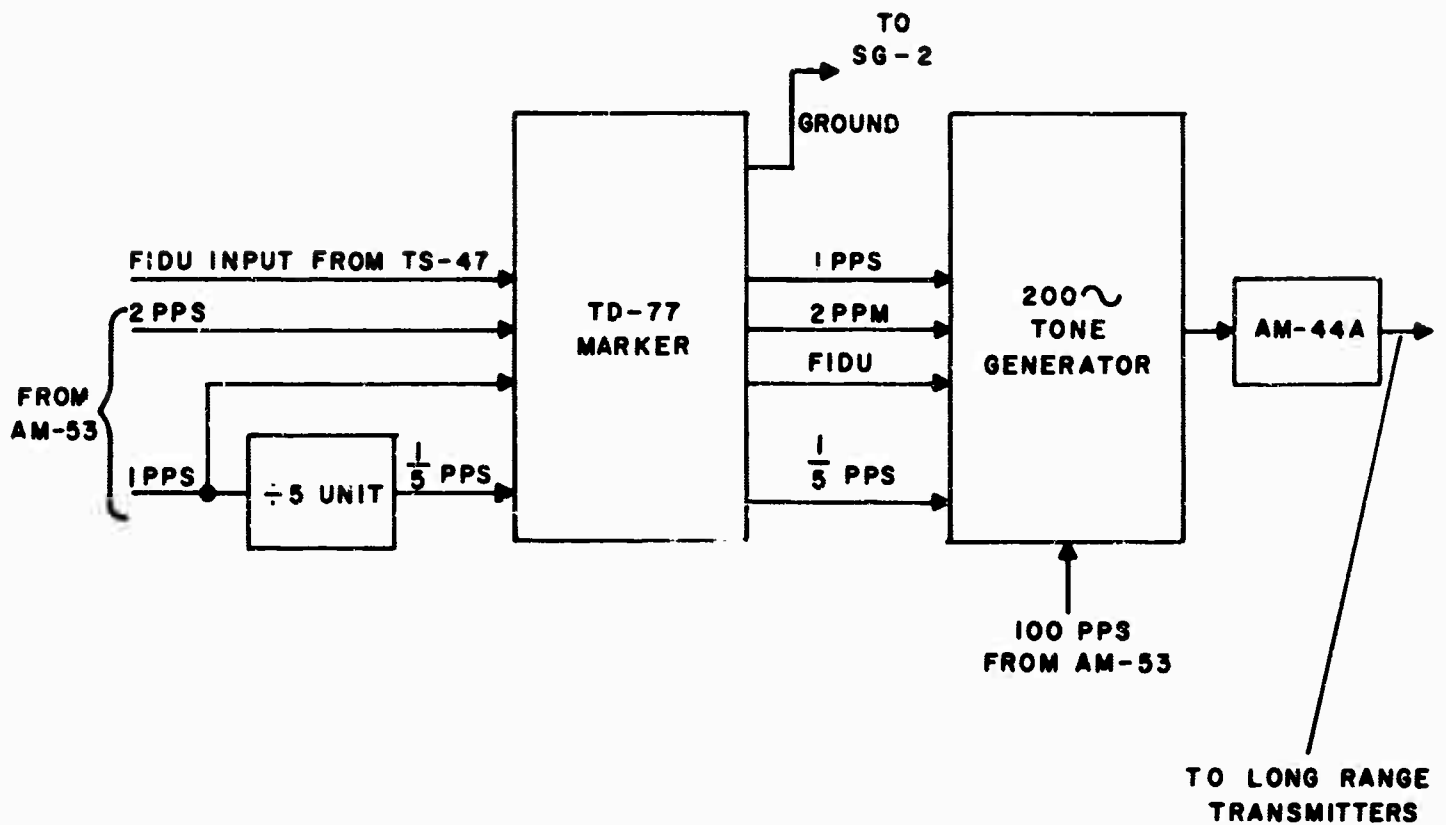


Fig. 3.2. Tone Generator Circuit Used on Salmon Event.

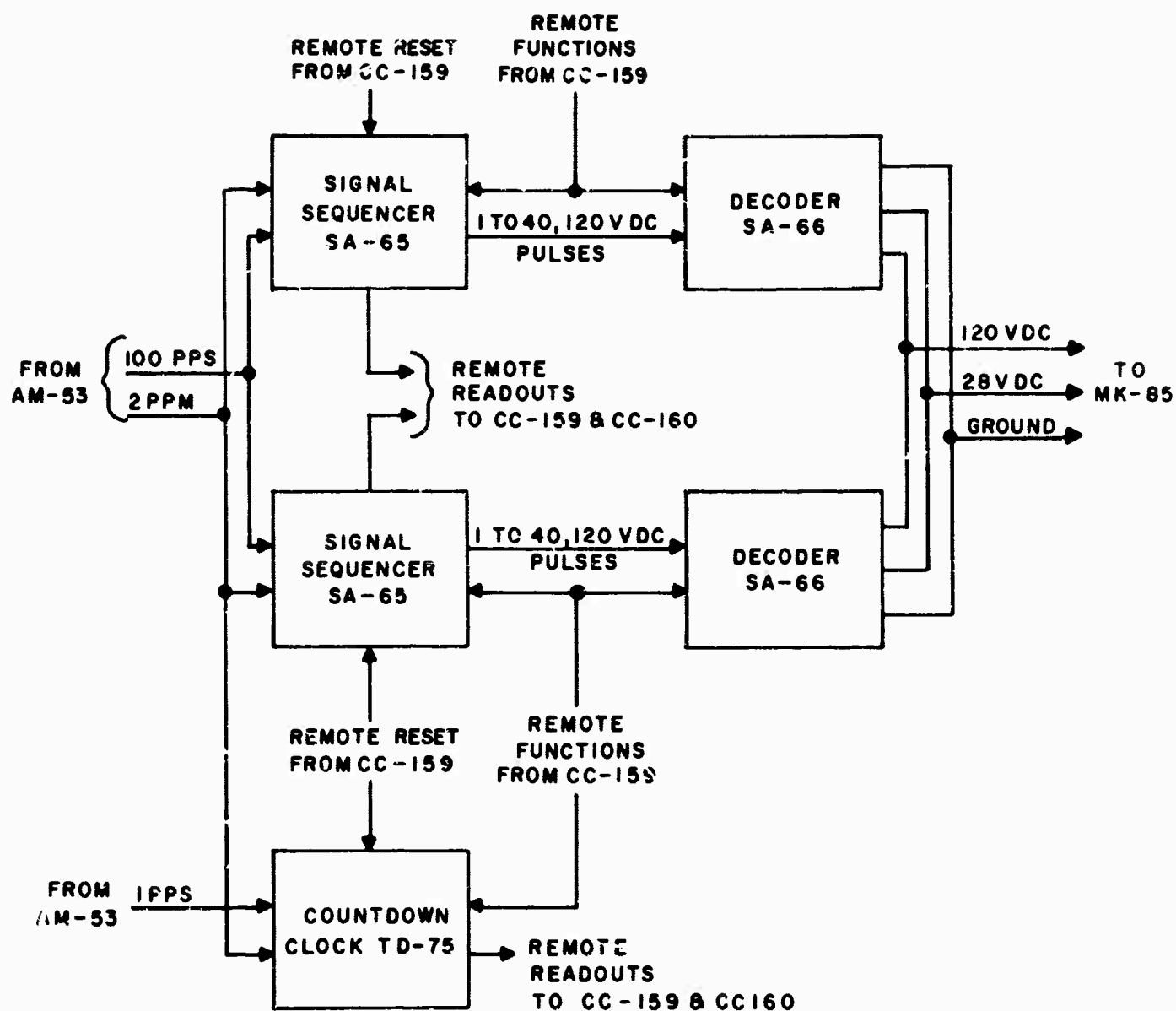


Fig. 3.3. Timing System.

### 3.1.3 Signal Distribution System (Fig. 3.4)

The signal distribution system facilitates the distribution of outputs generated by the timing system to the user relays via radio and hardwire systems. To accomplish these functions, the signal distribution system provides (1) monitor voltages which energize appropriate lamps in two indicator panels and pen-recorder circuits within two 40-pen recorders; (2) programmed ground potentials to activate circuits within a radio-control tone generator in the radio command system; (3) programmed signal voltages to excite time-of-event recording equipment in the World Time system; and (4) sequenced voltages to energize user relays, via four signal distribution units, as required. The latter voltages may also be interlocked through an interlock panel within the signal distribution system to provide protection of any arm or fire signals that are processed by this subsystem. Equipment units comprising the signal distribution system include:

- (1) one Meter Patch Panel, Type MK-85,
- (2) four Signal Distribution Units, Type SA-16,
- (3) two Esterline-Angus 40-pen Recorders, and
- (4) two Indicator Panels, Type ID-2B.

### 3.1.4 Radio Command System (Fig. 3.5)

The radio command system parallels the hardwire effort of the signal distribution system, providing a means of radio distribution of the outputs generated by the timing system. Programmed ground potentials as received from the signal distribution system are processed within the radio command system and appear as modulating voltage outputs. The outputs are furnished to remote transmitters for radio transmittal to remote user sites. Equipment units comprising the radio command system include:

- (1) one Radio Control Tone Generator, Type SG-2
- (2) one Single Tone Test Keyer, Type KY-1, and
- (3) three 60-watt VHF transmitters, Type TM-2.

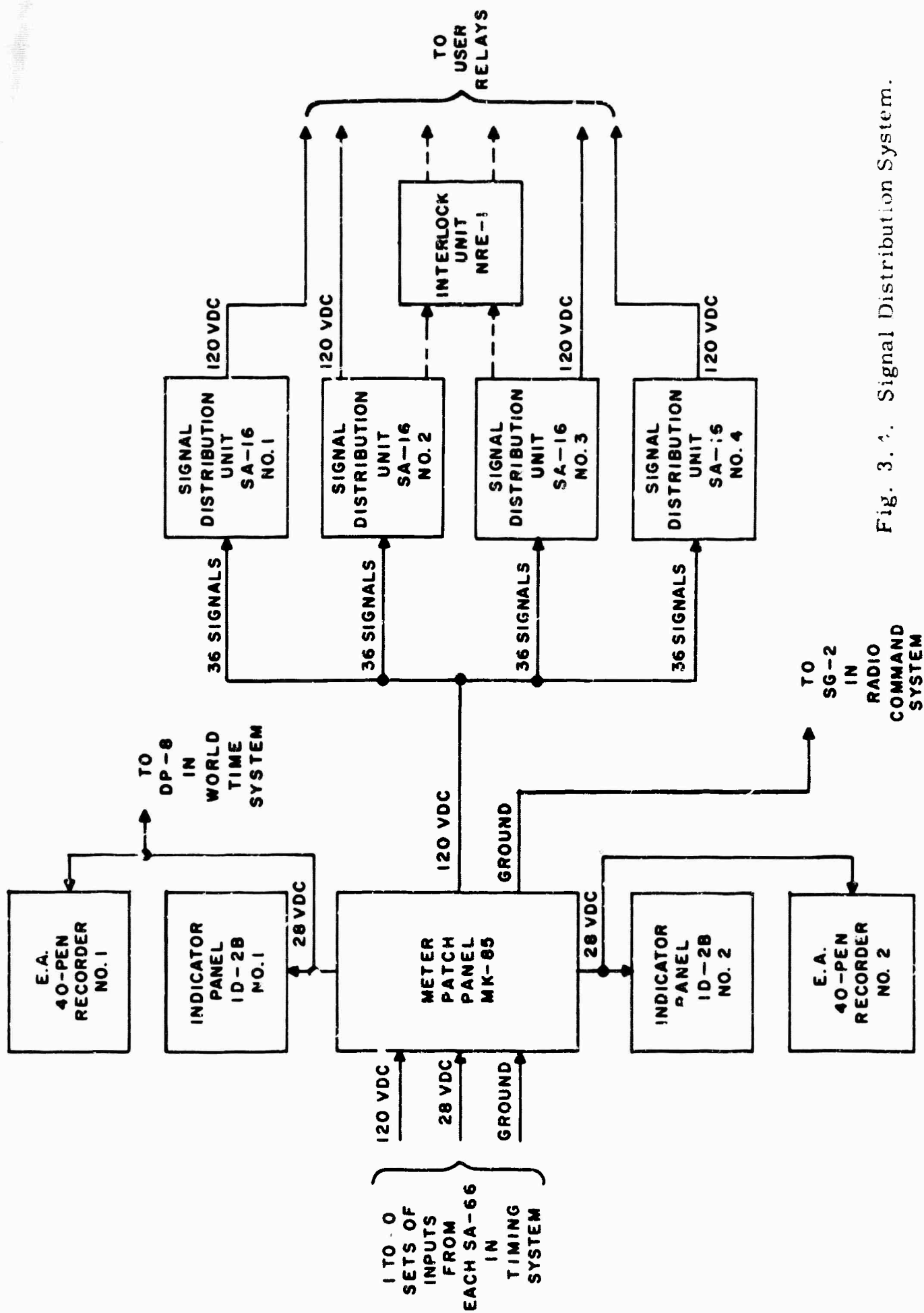


Fig. 3.4. Signal Distribution System.



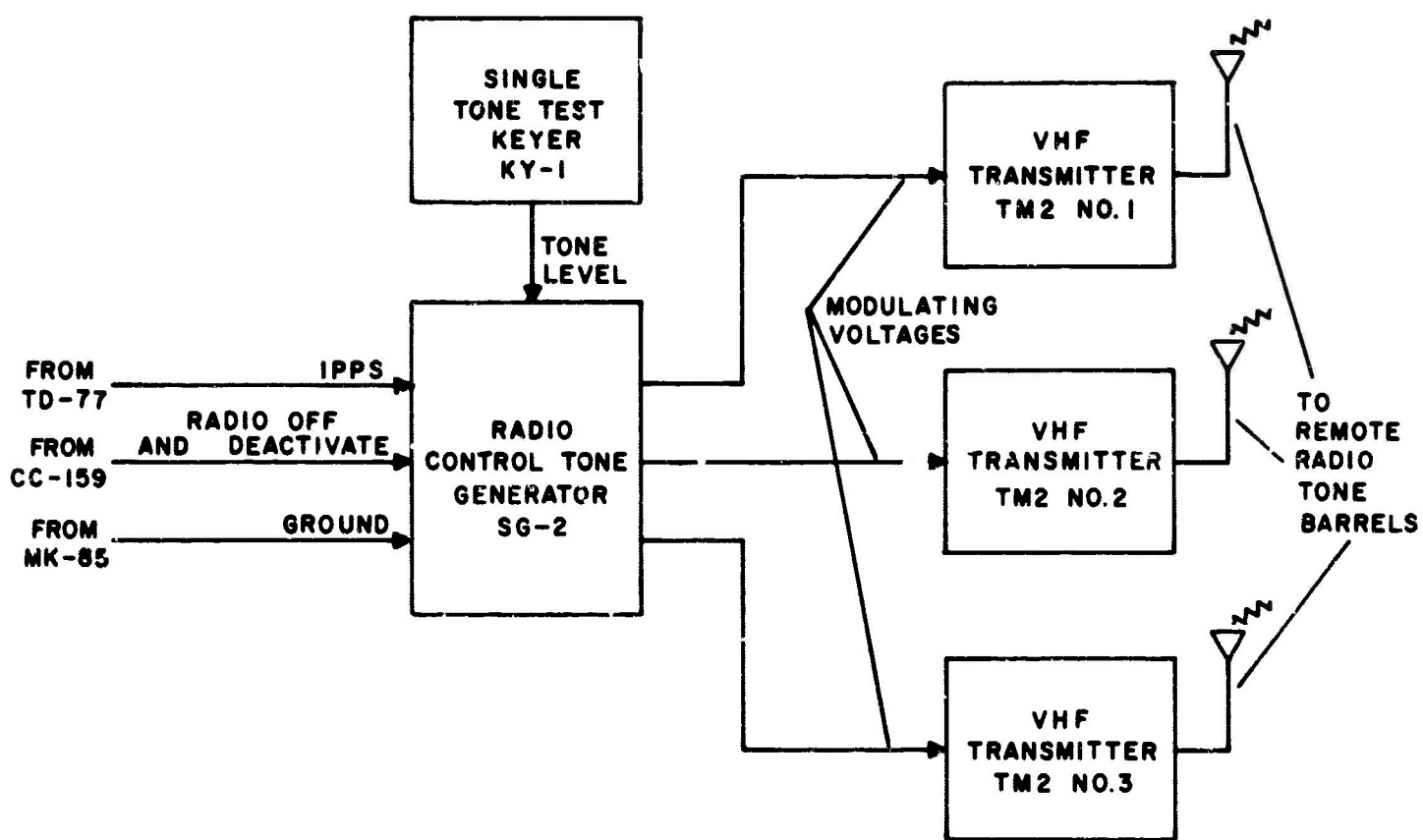


Fig. 3.5. Radio Command System.

#### 3.1.5 Radio Monitor System (Fig. 3.6)

Verification of the output of the radio command system is provided within the T&F system by the radio monitor system. This subsystem monitors the outputs of the VHF transmitters utilized by the radio command system, converts the r-f inputs to signal voltages, and applies these voltages to a companion indicator panel and to selected pen circuits within a 40-pen recorder in the signal distribution system. Equipment units comprising the radio monitor system include:

- (1) one VHF Control Receiver, Type RC-1, and
- (2) one Indicator Panel, Type ID-2B.

#### 3.1.6 Hardwire Monitor System (Fig. 3.7)

The hardwire monitor system provides the T&F system with a means of monitoring remote relay closures utilizing hardwire as opposed to radio. As remote relays close, these closures are processed by the hardwire monitor system and applied as signal voltages to an indicator panel and 40-pen recorder within the signal distribution system, where they appear as lamp illuminations and chart transcripts, respectively. Two Control Relay Panels, Type RE-42A, comprise the hardwire monitor system.

Although the T&F system employs a radio monitor system, which in some cases may parallel the hardwire monitor system, the latter system is by nature more accurate than the former, due to the inherent delay of the various components in the radio system. Therefore, the hardwire monitor system is generally preferred, if conditions allow. The feasibility of the hardwire system depends on the distance and location of the various sites and control locations.

#### 3.1.7 Power Distribution System (Fig. 3.8)

The T&F system utilizes a power distribution system to furnish, distribute and monitor various operating voltages as may be required by

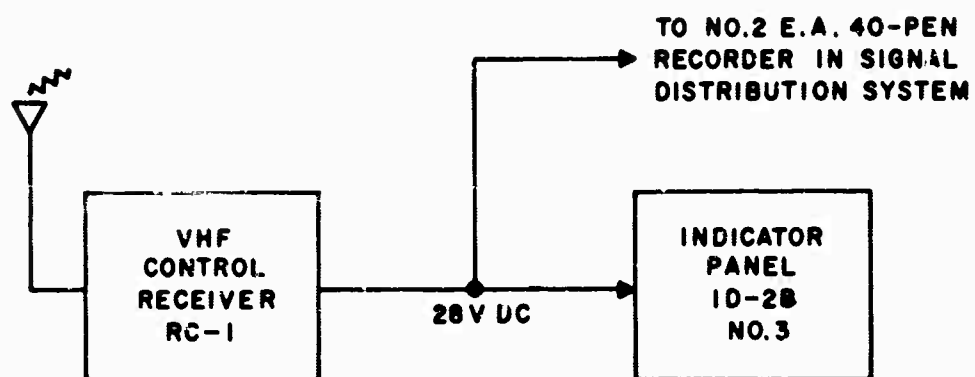


Fig. 3.6. Radio Monitor System.

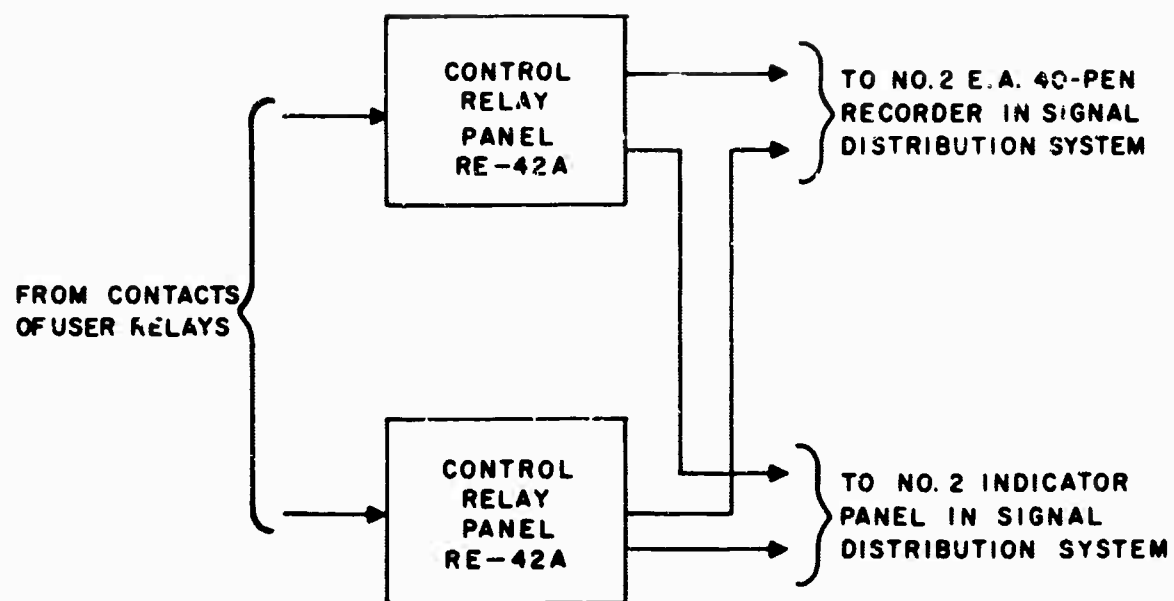


Fig. 3.7. Hardwire Monitor System.



the system. In the event of a primary power supply failure, provisions are incorporated within this subsystem to furnish backup battery-supplied power which will maintain the operating voltages required by the T&F system. Also included within the power distribution system is an emergency-stop, relay panel capable of removing operating voltages of 115 v ac, 120 v dc, and 28 v dc from equipment units within the timing rack (countdown clock, signal sequencer, and decoder). This function, originated at the master control console in the World Time system, will interrupt any system sequence in progress. Equipment units comprising the power distribution system include:

- (1) one Main Breaker Panel,
- (2) one Bogue unit (consisting of a control circuit, a-c motor, a-c generator, and d-c motor generator),
- (3) one battery bank,
- (4) two a-c and one d-c breaker panels,
- (5) two Perkin 120 VDC power supplies,
- (6) two Perkin 28 VDC power supplies,
- (7) one Esterline-Angus 115 VAC Power Recorder,
- (8) one Esterline-Angus 120 and 30 VDC Power Recorder,
- (9) one Voltage Monitor, Type CV-5A, and
- (10) one Emergency Stop Relay Panel, Type RE-15.

### 3.1.8 Communications System (Fig. 3.9)

The EG&G communications responsibilities on the Salmon event included (1) transmission of the countdown via local, long-range, and worldwide nets; and (2) providing local nets for on-site experimenters. Via telephone link, the countdown initiation time was transmitted to the EG&G Las Vegas laboratory and broadcast worldwide from there.

All EG&G-supplied communications equipment in support of the Dribble Program was located in the T&F trailer. Control of an audio-distribution panel allowed EG&G to provide keying and audio functions

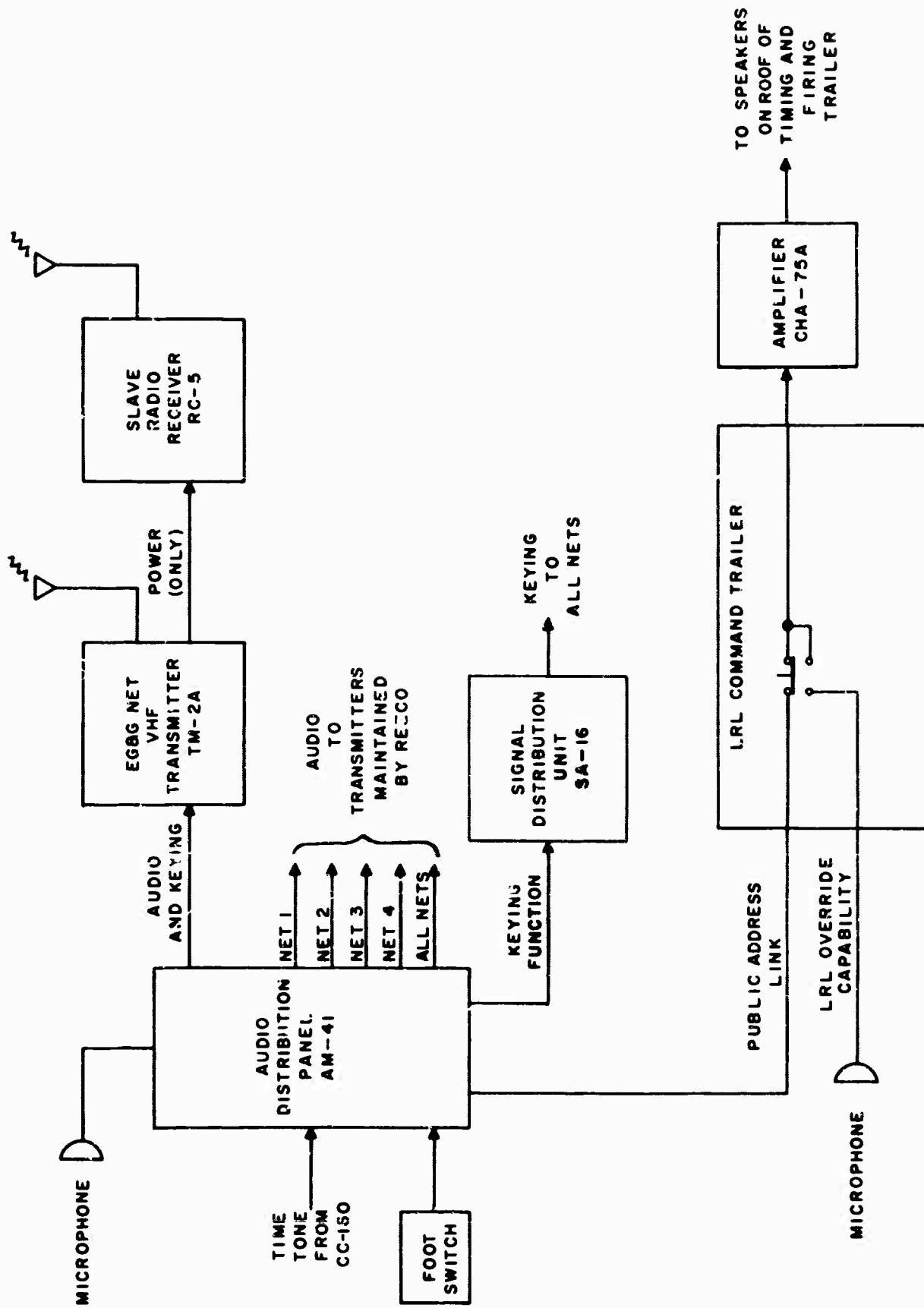


Fig. 3.9. Communication System.

for the EG&G company net, remote user transmitters (maintained by REECO) and the Public Address system. LRL personnel located in the Technical Director Manned Site (TDMS) trailer maintained a complete override capability of the Public Address system. Equipment units comprising the communications system included:

- (1) one Audio Distribution Panel, Type AM-41,
- (2) one VHF Transmitter, Type TM-2A
- (3) one Slave Radio Receiver, Type RC-5,
- (4) one Signal Distribution Unit, Type SA-16, and
- (5) one Amplifier, Type CHA-75A.

### 3.2 ZERO ROOM INSTRUMENTATION

EG&G provided Zero Room equipment installation for detonation of the device and for monitoring this occurrence. Equipment units comprising the EG&G Zero Room installation included:

- (1) one Universal Zero Rack, Type SA-57,
- (2) one Red Box, Type RE-43,
- (3) one Fidu Line Pulser, Type TS-47,
- (4) one Battery Charger, Type PS-4A,
- (5) one Esterline-Angus 115 VAC and 30 VDC Power Recorder,
- (6) one 30-v Battery Bank,
- (7) one DC Voltage Monitor, Type CV-4, and
- (8) one Signal Simulator, Type SM-8.

### 3.3 FIELD INSTRUMENTATION

EG&G provided field instrumentation in the form of twenty-two VHF radio receivers (tone barrels) and forty-five relay boxes to facilitate closing of experimenter relays at remote sites via radio and hardwire signals.



TECHNICAL AND SAFETY PROGRAM REPORTS SCHEDULED FOR ISSUANCE  
BY AGENCIES PARTICIPATING IN PROJECT DRIBBLE

SAFETY REPORTS

| <u>Agency</u> | <u>Report No.</u> | <u>Subject or Title</u>   |
|---------------|-------------------|---|
| USWB          | VUF-1020          | Weather and Surface Radiation Prediction Activities   |
| USPHS         | VUF-1021          | Final Report of Off-site Surveillance   |
| USEM          | VUF-1022          | Pre and Post-Shot Safety Inspection of Oil and Gas Facilities Near Project Dribble                              |
| USGS          | VUF-1023          | Analysis of Geohydrology of Tatum Salt Dome   |
| USGS          | VUF-1024          | Analysis of Aquifer Response  |
| REECo         | VUF-1025          | On-Site Health and Safety Report  |
| RFB, Inc.     | VUF-1026          | Analysis of Dribble Data on Ground Motion and Containment - Safety Program                                      |
| H-NSC         | VUF-1027          | Ground-Water Safety   |
| FAA           | VUF-1028          | Federal Aviation Agency Airspace Advisory   |
| H&N           | VUF-1029          | Summary of Pre and Post-Shot Structural Survey Reports  |
| JAB           | VUF-1030          | Structural Response of Residential-Type Test Structures in Close Proximity to an Underground Nuclear Detonation |
| JAB           | VUF-1031          | Structural Response of Tall Industrial and Residential Structures to an Underground Nuclear Detonation.         |

NOTE: The Seismic Safety data will be included in the USC&GS Technical Report VUF-3014

TECHNICAL REPORTS

| <u>Agency</u> | <u>Report No.</u> | <u>Subject or Title</u>  |
|---------------|-------------------|--|
| SL            | VUF-3012          | Free-field Particle Motions from a Nuclear Explosion in Salt - Part I  |
| SRI           | VUF-3013          | Free-Field Particle Motions from a Nuclear Explosion in Salt - Part II |
| USC&GS        | VUF-3014          | Earth Vibration from a Nuclear Explosion in a Salt Dome                |
| UED           | VUF-3015          | Compressional Velocity and Distance Measurements in a Salt Dome        |

|      |            |  |
|------|------------|--|
| IRL  | VUF-3016   | Design and Operation of a Chemical Processing Plant for Controlled Release of a Radioactive Gas from the Cavity of a Nuclear Explosion in Salt |
| IRL  | PNE-3002 * | Response of Test Structures to Ground Motion from an Underground Nuclear Explosion   |
| SRI  | VUF-3017   | Feasibility of Cavity Pressure and Temperature Measurements for a Decoupled Nuclear Explosion  |
| IRL  | VUF-3018   | Background Engineering Data and Summary of Instrumentation for a Nuclear Test in Salt  |
| WES  | VUF-3019   | Laboratory Design and Analyses and Field Control of Grouting Mixtures Employed at a Nuclear Test in Salt                                       |
| IRL  | VUF-3020   | Geology and Physical and Chemical Properties of the Site for a Nuclear Explosion in Salt   |
| EG&G | VUF-3021   | Timing and Firing  |

\* This report number was assigned by SAN

In addition to the reports listed above as scheduled for issuance by the Project DRIBBLE test organization, a number of papers covering interpretation of the SALMON data are to be submitted to the American Geophysical Union for publication. As of February 1, 1965, the list of these papers consists of the following:

| <u>Title</u>  | <u>Author(s)</u>                              | <u>Agency(s)</u>       |
|---|---|------------------------|
| Shock Wave Calculations of Salmon   | L. A. Rogers                                  | IRL                    |
| Nuclear Decoupling, Full and Partial  | D. W. Patterson                               | IRL                    |
| Calculation of P-Wave Amplitudes for Salmon   | D. L. Springer and<br>W. D. Hurdlow           | IRL                    |
| Travel Times and Amplitudes of Salmon Explosion                                     | J. N. Jordan<br>W. V. Mickey<br>W. Helterbran | USC&GS<br>AFTAC<br>UED |
| Detection, Analysis and Interpretation of Teleseismic Signals from the Salmon Event | A. Archambeau and<br>E. A. Flinn              | SDC                    |
| Epicenter Locations of Salmon Event   | E. Herrin and<br>J. Taggart                   | SMU<br>USC&GS          |
| The Post-Explosion Environment Resulting from the Salmon Event                      | D. E. Rawson and<br>S. M. Hansen              | IRL                    |
| Measurements of the Crustal Structure in Mississippi                                | D. H. Warren<br>J. H. Healy<br>W. H. Jackson  | USGS                   |

All but the last paper in the above list will be read at the annual meeting of the American Geophysical Union in April 1965.

# LIST OF ABBREVIATIONS FOR TECHNICAL AGENCIES

|          |  |           |  |
|----------|--|-----------|--|
| BR LTD   | Barringer Research Limited<br>Rexdale, Ontario, Canada   | RFB, INC. | R. F. Beers, Inc.<br>Alexandria, Virginia                    |
| ERDL     | Engineering Research<br>Development Laboratory<br>Fort Belvoir, Virginia                                       | SDC       | Seismic Data Center<br>Alexandria, Virginia                  |
| FAA      | Federal Aviation Agency<br>Los Angeles, California   | EG&G      | Edgerton, Germeshausen &<br>Grier, Inc.<br>Las Vegas, Nevada |
| GIMRADA  | U. S. Army Geodesy, Intelli-<br>gence and Mapping Research<br>and Development Agency<br>Fort Belvoir, Virginia | SL        | Sandia Laboratory<br>Albuquerque, New Mexico                 |
| H-NSC    | Hazleton-Nuclear Science<br>Corporation<br>Palo Alto, California   | SMU       | Southern Methodist University<br>Dallas, Texas               |
| H&N, INC | Holmes & Narver, Inc.<br>Los Angeles, California<br>Las Vegas, Nevada  | SRI       | Stanford Research Institute<br>Menlo Park, California        |
| II       | Isctopes, Inc.<br>Westwood, New Jersey   | TI        | Texas Instruments, Inc.<br>Dallas, Texas                     |
| ITEK     | Itek Corporation<br>Palo Alto, California  | UA        | United Aircraft<br>El Segundo, California                    |
| JAB      | John A. Blume & Associates<br>Research Division<br>San Francisco, California                                   | UED       | United Electro Dynamics, Inc.<br>Pasadena, California        |
| IRL      | Lawrence Radiation Laboratory<br>Livermore, California   | USEM      | U. S. Bureau of Mines<br>Washington, 25, D. C.               |
| NRDL     | U. S. Naval Radiological<br>Defense Laboratory<br>San Francisco, California                                    | USC&GS    | U. S. Coast and Geodetic<br>Survey<br>Las Vegas, Nevada      |
| REECo    | Reynolds Electrical &<br>Engineering Co., Inc.<br>Las Vegas, Nevada  | USGS      | U. S. Geologic Survey<br>Denver, Colorado                    |
|          |  | USPHS     | U. S. Public Health Service<br>Las Vegas, Nevada             |
|          |  | USWB      | U. S. Weather Bureau<br>Las Vegas, Nevada                    |